BNFL Inc.

Section 2.10

Other Events

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2.10.0. Introduction

The initial set of Design Safety Features was developed by consideration for potential hazards and hazardous situations that might occur within specific structures, systems, and components (SSCs). Hazards and hazardous situations that might occur external to the facility include severe natural phenomena hazards (NPH), nearby radiological and chemical facilities, and nearby transportation. Hazardous situations that might occur within the facility but external to the specific SSCs include common cause events such as fire, flooding, high energy line breaks, internally generated missiles, and loss of offsite power. Loss of offsite power considers both loss of power to the facility and plant-centered loss of power.

These events (i.e., NPH and External Events and Common Cause Failures) are addressed in the following tables. In addition, Criticality is included here as it is a hazardous situation that is not associated with one particular system or component.

The Important to Safety (ITS) SSCs identified in the following tables are generally passive features of the structural design. While these features are complex in their design and construction, they tend to be simplified and inherently safe in terms of achieving their design safety functions. Also, the design and construction of steel and concrete structures are known to be very conservative with regard to the ability of the structures to withstand dead and live loadings considerable in excess of their design requirements.

Active ITS systems identified in the following tables include the HVAC, Instrumentation and Control, and Electrical systems. The design safety features of these systems and their support systems are addressed in Section 2.2, “Ventilation Systems,” Section 2.3, “Electrical Systems,” and Section 2.4, “Instrumentation and Control Systems.” The design safety features required of these support systems are identified in the tables that follow.

2.10.1. Natural Phenomena Hazards and External Events

Table 2.10-1. Natural Phenomena Hazards and External Events

Fault	Important to Safety SSCs	Safety Function	DSFs
Seismic event leading to a loss of confinement or damage to ITS equipment.	Structures and components (including confinement boundaries and equipment supports) and "two-over-one" features as necessary to prevent the release of radiological and hazardous materials for a seismic event. Tanks that contain a significant inventory of radionuclides (e.g., the HLW receipt tanks, HLW solid storage tanks, HLW melter blending tank, HLW melter blending tank, and the cesium-technetium product storage tank). Also, ITS front line and support systems that have mitigation functions for a seismic event.	The guiding safety functions are to maintain exposures to the facility and co-located workers and the public to within established standards for a seismic event and provide for defense in depth. To satisfy this safety function, the following must be achieved for SSCs that have a seismic mitigating function: Structures (e.g., caves and cells) and components (e.g., tanks and piping) must remain intact "Two-over-one" features must not lead to failure of exposed ITS SSCs Front line and support systems need to function during and/or after a seismic event. These would be designated as ITS.	Structures and confinement barriers and most "two-over-one" features are passive, and therefore have a high degree of reliability. Fragility analysis for structures and confinement boundaries similar to those of the TWRS-P* Facility have shown them to remain intact for events that significantly exceed the design basis earthquakes. This has also been found true for SSCs (including piping systems) that have experienced earthquakes in California, Japan, Chile, San Salvador, and Mexico. SRD Safety Criterion 4.4-12 requires qualification of electrical systems to IEEE 344. This provides confidence that electrical systems credited for seismic mitigation will withstand seismic events. Compliance DOE O 420.1 (Section 4.4) DOE IG-420.1.4 DOE-STD 1020, ACI-318, ACI 349, ASCE/AISC N690, and ASCE 4-86 are elements of the facility design that provide assurance the ITS SSCs will meet these seismic mitigating requirements. The establishment of the design basis earthquake is conservative relative to what is expected during the life of the TWSR-P Facility.

Table 2.10-1. Natural Phenomena Hazards and External Events

Fault	Important to Safety SSCs	Safety Function	DSFs
Straight Wind leading to damage of ITS equipment.	External structures.	Protect ITS systems and components from high winds. The high wind loading is converted to an effective pressure. The safety function of the external structures is to withstand this effective pressure.	Structures are passive features designed to withstand the design basis wind loading to prevent structural damage such that ITS systems and components located within the structures are protected from damage. Compliance to UBC 1997, DOE Interim Advisory on Straight Winds (1/22/98), ACI 349, AISC N690, and ASCE 7-95 are elements of the structural design that provide assurance the structures are of adequate strength to withstand straight wind loading. The establishment of the design basis straight wind is conservative relative to what is expected during the life of the TWSR-P Facility. Defense in depth is provided by the location of the significant quantities of radionuclides in cells and caves that provide additional protection should portions of the outer building structure fail by high wind loading.

Table 2.10-1. Natural Phenomena Hazards and External Events

Fault	Important to Safety SSCs	Safety Function	DSFs
Wind Missile leading to damage of ITS equipment.	External structures.	Protect ITS systems and components from wind missile.	Structures are passive features designed to withstand the design basis wind-lifted missile thereby preventing damage to ITS systems and components located within the structures. Compliance to UBC 1997, ACI 349, AISC N690, and ASCE 7-95 are elements of the structural design that provide assurance the structures are of adequate strength to withstand wind missile impact. The establishment of the design basis wind-lifted missile is conservative relative to what is expected during the life of the TWSR-P Facility. Defense in depth is provided by the location of the significant quantities of radionuclides in cells and caves that provide additional protection should the outer building structure be penetrated by a missile.

Table 2.10-1. Natural Phenomena Hazards and External Events

Fault	Important to Safety SSCs	Safety Function	DSFs
Volcanic Ash leading to damage of ITS equipment.	External structures.	Protect ITS systems and components from ash loading.	Structures are passive features designed to withstand the design basis ash loading such that ITS systems and components located within the structures are protected from damage. Compliance to UBC 1997, ACI 349, AISC N690, and ASCE 7-95 are elements of the structural design that provide assurance the structures are of adequate strength to withstand the design basis ash loading. The establishment of the design basis ash loading is conservative relative to what is expected during the life of the TWSR-P Facility. (i.e., relative to the ashfall for the 1980 eruption of Mount St. Helens, considered to be the most active of the nearby volcanoes throughout the last 10,000 years). Defense in depth is provided by the location of the significant quantities of radionuclides in cells and caves that provide additional protection should portions of the building roof fail by ash loading.

Table 2.10-1. Natural Phenomena Hazards and External Events

Fault	Important to Safety SSCs	Safety Function	DSFs
	HVAC System (See Section 2.2, Ventilation Systems).	Protect equipment from damage by ash.	The HVAC systems remove ash material from make-up air such that ash distribution and deposition within the facility is not a concern. Louvres of air intake points are designed to remove bulk loading. Filters on air handling units for C1/C2 supply will remove ash material. Special features may need to be provided to prevent excessive loading of the filtration provided for the diesel combustion air intake. This may include use of rolling filters or frequent filter replacement. Filtration of the diesel combustion air intake must be immediate as ash fall can lead to a loss of offsite power (e.g., due to flashover on power lines) requiring the starting and loading of the diesel.

Table 2.10-1. Natural Phenomena Hazards and External Events

Fault	Important to Safety SSCs	Safety Function	DSFs
Snow Load leading to damage of ITS equipment.	External structures.	Protect ITS systems and components from snow loading.	Structures are passive features designed to withstand the design basis snow loading (including snow drift) to prevent structural damage such that ITS systems and components located within the structures are protected from damage. Compliance to UBC 1997, ACI 349, AISC N690, and ASCE 7-95 are elements of the structural design that provide assurance the structures are of adequate strength to withstand the design basis snow loading. The establishment of the design basis snow load is conservative relative to what is expected during the life of the TWSR-P Facility. Defense in depth is provided by the location of the significant quantities of radionuclides in cells and caves that provide additional protection should portions of the building roof fail by snow loading.

Table 2.10-1. Natural Phenomena Hazards and External Events

Fault	Important to Safety SSCs	Safety Function	DSFs
Probable Maximum Precipitation (PMP)-Induced Internal Flooding leading to damage of ITS equipment.	External structures and roof and site grading and drainage.	Roof drainage and limited parapet height function to limit roof loading. Site drainage, grading, exterior barriers, and location of openings function to prevent water entry into buildings thereby protecting ITS systems and components from water damage.	Building structural design features (e.g., roof design and drainage and location of building openings), use of exterior barriers, and site drainage are passive features designed to withstand the design basis PMP to prevent exposing ITS systems and components to water damage. Inspection of drainage features will receive periodic inspection to identify if they are block. The establishment of the design basis PMP is conservative relative to what is expected during the life of the TWSR-P Facility.
External Fires (Range Fire).	Fire breaks (e.g., gravel or landscaping) and external hydrants.	Fire breaks provide a buffer zone for range fires and hydrants allow for suppression of fires that may challenge the firebreak.	The firebreak is of sufficient width to prevent the heat from a range fire from impacting the facility. The hydrants are defense in depth features located such that a range fire approaching the facility from any direction can be suppressed.
Fault at nearby Radiological Facilities leading to radiological exposure to personnel.	Fresh air supply activity monitors.	Detects high activity in inlet air.	Trouble alarm battery-backed.
	Isolation Damper	Isolates inlet supply system to limit the ingress of airborne contamination.	Designed to withstand maximum depression of inlet/extract fan. MOV with manual override damper indication.

Table 2.10-1. Natural Phenomena Hazards and External Events

Fault	Important to Safety SSCs	Safety Function	DSFs
	Emergency ventilation system for control room.	See Vent System Table 2.2.3.	Implementation of NUREG-800 (SRP 6.4), ASME N 509 and 510, and UL 586 are elements of the HVAC design and testing that provide assurance the HVAC will be effective in protecting the operators. If operator action is required to place the facility in a safe state following an external event, then the removal of radioactive particulate by the HVAC must be immediate with automatic starting and loading on the diesel in case of loss of offsite power.
Fault at nearby Industrial Facilities leading to chemical exposure to operators or damage to ITS equipment.	HVAC (See Section 2.2, "Ventilation Systems").	Limit personnel chemical exposure to operators from events at nearby facilities as needed to achieve a safe state.	The HVAC system provided for the control room and other occupied areas can be operated in a recirculation mode if necessary to ensure exposure standards are not exceeded. When operating in the recirculation mode, air infiltration is considered. Self-contained breathing apparatus may be used if the duration of the chemical exposure is not great. Evaluation of chemical releases to NRC Reg. Guide 1.78 is an element of the HVAC design that provides assurance the design and emergency procedures are adequate.

Table 2.10-1. Natural Phenomena Hazards and External Events

Fault	Important to Safety SSCs	Safety Function	DSFs
	External structures.	Prevent direct damage to facility.	Structures are evaluated for nearby explosions. In most cases, the design requirements for seismic and wind loading provide assurance the building will withstand the overpressure from explosions. NRC Reg. Guide 1.91 provides guidance for the evaluation of explosions on nearby transportation routes; also useful for evaluating nearby industrial facilities. Defense in depth is provided by the location of the significant quantities of radionuclides in cells and caves that provide additional protection against overpressure that might be present for a nearby explosion.
Transportation. Fault leading to chemical exposure to operation or damage to ITS equipment.	HVAC (See Section 2.2, "Ventilation Systems").	Limit personnel chemical exposure to operators from nearby transportation events as needed to achieve a safe state.	See above DSFs for Nearby Industrial Facilities, HVAC.
	External structures, cells, and caves.	Prevent direct damage to facility.	See above DSFs for Nearby Industrial Facilities, External structures. In addition, implementation of DOE-STD-3014 provides assurance that adequate protection is provided for commercial and general aviation aircraft impact. General aviation class aircraft contribute most of the overall crash frequency to the facility. For SSCs located within cells and caves, the strength of these barriers will provide adequate protection against general aviation aircraft.

2.10.2. Common Cause Events

Table 2.10-2. Common Cause Events

Fault	Important to Safety SSCs	Safety Function	DSFs
Loss of Offsite Power (includes plant-centered events leading to loss of electrical power). (Note; features of the electrical distribution system not directly related to common cause loss of electrical power are addressed in Section 2.3, Electrical Systems)	Emergency Generator	Provide electrical power for a loss of offsite power.	Automatic Start on loss of offsite power Fuel supply for several days Periodic testing Proven technology Trouble alarms. (See Section 2.3, Electrical Systems).
	Uninterruptible Power Supplies	Provide electrical power to equipment that cannot tolerate power interruption during diesel start.	Periodic testing Proven technology Trouble alarms. (See Section 2.3, Electrical Systems).
	Transfer devices	Provide for transfer from the normal to alternate power source.	Periodic testing under load conditions to confirm transfer
	Physical and electrical separation of redundant portions of the electrical distribution system	Ensure that events such as fire, high-energy line breaks (HELB), flooding, internally-generated missiles, and electrical shorts do not disable both trains of electrical supply.	Physical barriers such as walls protect redundant trains against fire, HELB, and internally-generated missiles. Shields can also provide protection against the jet-impingement affects of HELB and internally-generated missiles. Physical separation by distance and electrical isolation provide protection against a electrical short in one train adversely impacting the second train. (See Section 2.3, Electrical Systems).

Table 2.10-2. Common Cause Events

Fault	Important to Safety SSCs	Safety Function	DSFs
Natural Phenomena Hazards.	Natural Phenomena Hazards are addressed in the Natural Phenomena Hazards and External Events table.		
Internal Flooding / In-cell.	Sump level indications, alarms on high level, automatic isolation of feed lines, and cell drainage (pump out) (See Section 2.4.3, "Independent Detection and alarm Systems"). Note: not all feed lines have automatic isolation and not all cells automatically initiate pump out on high-high sump level.	Protect ITS SSCs located within cell from internal flooding.	The sump level indication and alarm provides notification to the operator of a potential in-cell leak (tank or piping) or tank overfill situation that is beginning to flood the cell. Automatic isolation, when provided, terminates flooding if operator response in response to the alarm does not occur. Cell pump out, whether automatic or manual on high sump level, removes liquid from the cell. Routine calibration of the level sensors and functional testing of the instrument channels, valves, and pumps provides assurance that these features will perform their required safety function.
Internal Flooding / Out of Cell.	Barriers, enclosures, and floor drains.	Protect ITS SSCs located out of cell from internal flooding. This would be applied to ITS SSCs necessary for achieving a safe state in response to a flooding event and for preventing uncontrolled release of radiological or hazardous material for such an event.	SSCs requiring protection to achieve the specified safety function are located above the flooding level or are protected for immersion.
Fire.	Internal fires are addressed in Section 2.9, "Fire Protection." External fires are addressed in Section 10.2.1 "Natural Phenomena Hazards and External Events."		

Table 2.10-2. Common Cause Events

Fault	Important to Safety SSCs	Safety Function	DSFs
Internally-Generated Missiles. (Note; components within one train are not protected from missiles originating from this train; protection is only provided for the redundant train).	Physical separation by barriers (maybe by existing walls or special protective shields or barriers).	Stop or deflect missile such that the redundant ITS train is not impacted by the missile.	Barriers are passive components. Design to standard approaches for the analysis of missile impact provides assurance the barrier will protect the ITS SSCs. A detailed review is performed of the facility design to ensure credible generators of missiles are identified for evaluation.
High Energy Line Breaks (HELB) – Environmental Effects. (HELBs are associated with systems that during normal operation have maximum operating pressure > 275 psi or a maximum operating temperature > 200 F).	Physical separation by location of the HELB related ITS SSCs[1] such as in separate rooms.	Prevent the environmental affects of the HELB (usually elevated temperature, humidity, or spray wetting) from adversely impacting HELB related ITS SSCs[1].	Room barrier design or location to prevent the released gas from damaging the HELB related ITS SSCs[1]. This includes consideration for room wall design and isolation of common HVAC.
	Qualification of the HELB related ITS SSCs[1] for the elevated environmental condition (usually temperature, humidity, or spray wetting).	Allow the HELB related ITS SSCs[1] remain functional for the HELB elevated environmental conditions.	Vendor testing to confirm the exposed ITS components will perform their HELB mitigating safety function for the elevated environmental conditions.
	Automatic isolation of failed high-energy system	To prevent the HELB related ITS SSCs[1] from being exposed to the elevated environmental conditions.	Testing and calibration of the leak detection system and testing of the valve closure time to confirm the leak is detected and isolated before a condition is reached for which the equipment lacks qualification. .(See Section 2.4.2, Independent Protection systems for a general discussion of such protection systems)

Table 2.10-2. Common Cause Events

Fault	Important to Safety SSCs	Safety Function	DSFs
High Energy Line Breaks (HELB) – Jet Impingement Effects.	Physical separation or jet impingement barriers.	Prevent direct impact of the gas jet on the HELB related ITS SSCs[1].	The design of the barriers must be of sufficient strength to withstand the jet impingement. A facility walk down near end of construction is conducted to confirm all the required barriers have been installed.
High Energy Line Breaks (HELB) – Pipe Whip Effects.	Physical separation or installation of piping restraints.	Prevent impact of whipping pipe on the HELB related ITS SSCs[1].	The design of the barriers or pipe whip restraints must be of sufficient strength to withstand the pipe movement.
[1] "HELB related ITS SSCs" are those SSCs that have a role in HELB mitigation to prevent uncontrolled release of radiological or hazardous material in response to the HELB or to achieve a safe state for the facility in response to the HELB.			
Internally-Generated Missiles. (Note; components within one train are not protected from missiles originating within that train).	Physical separation by barriers (maybe by existing walls or special protective shields or barriers).	Stop or deflect missile such that those SSCs that have a role in preventing uncontrolled release of radiological or hazardous material or to achieve a safe state for the facility in response to the missile generation are free from damage.	Barriers are passive components. Design to standard approaches for the analysis of missile impact provides assurance the barrier will protect the ITS SSCs. A detailed review is performed of the facility design to ensure credible generators of missiles are identified for evaluation.

2.10.3. Criticality

Table 2.10-3. Criticality

Fault	ITS SSCs	Safety Function	DSFs
Criticality (by buildup of fissile material)	Vessels and piping for handling and storage of material that may contain fissile materials if the need for geometry control is identified. It is currently expected that by control of the feed material, geometry controls will not be required (Reference: *BNFL Inc. Work Plan for Criticality Safety Assessment During TWRS-P Part B.*)	Prevent criticality by geometry control to achieve application of the double contingency principle. The design and operation of the facility is to prevent criticality.	The criticality prevention features, if required are passive features. Configuration management will provide assurance these features remain in place and not inappropriately modified.